Ch 15- 18 Heat, Thermometer, Thermal Expansion

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| * All matter—   KE   * Solid, liquid, or gas.  * **[temperature](javascript:;)** | Solid, liquid, and gas—is composed of continuously jiggling; random motion= kinetic energy.  Kinetic energy; Energy of motion  an increase in temperature َ**~** increase in KE ~ increase in molecular movement~ increase in size   * The temperature of some quantity of matter by a number that corresponds to its degree of hotness or coldness on some chosen scale. * Is proportional to the average “kinetic energy (motion that carries the molecule from one place to another). – produces heat |
| * Hammer & penny | * Hit penny- produces heat * Energy added ~ KE ~ temp |
| Thermal Expansion  Normal fluids | Nearly all materials expand when their temperature is raised and contract when their temperature is lowered  When temp rises, material molecules speed up; increases area (expands)more  Add energy🡪 more active🡪 expands/increased pressure  Solid🡪add energy 🡪liquid 🡪 gas |
| Water  Hexagonal crystals | 100 degrees boil/condense (spread out due to thermal expansion); 4 degrees C most dense  0 degrees freeze/melt- crystals form/breakdown |
| **Heat transfer**  Insulators  Conductors  Valence electrons | Valence electrons held tight (liquids & gases) blankets on bed/ panes in window  transfer free valence electrons; metals; heat & electricity  outer shell electrons |
| **Thermometers**  **Absolute zero** | http://www.google.com/url?source=imglanding&ct=img&q=http://www.physicstutorials.org/images/stories/thermometertypeslast.png&sa=X&ei=Vv_DTpjWB-XS2gX6pMTEDg&ved=0CAsQ8wc&usg=AFQjCNFRVqUwlazkX2Wp71qJTiqYK1Zn_Q  For every 1 degree C drop the movement will slow 1/273 parts  When you reach -−273°C, all motion stops; absolutely no kinetic energy to give up |
| * Galileo –   Celsius scale  Kelvin scale-  **translational”**  **rotational or vibrational kinetic** | * 1st thermometer * - the international scale, 0 – freezes; 100 - water boils out * 0 is assigned to the lowest possible temperature— * Degrees are same size as degrees on the Celsius scale * —stays in one place, but moves; but these motions are not translational and don’t directly affect temperature. oscillating molecules don’t cook food- * The translational kinetic energy imparted to neighboring molecules that are bounced off the oscillating water molecules. |
| a thermometer really displays is its own temperature | * 10.3 m water * 760 cm mercury * Measure of energy content * If it feels hot- it is moving energy into your hand * If it is Cold- it is moving energy out of your hand * energy will flow between the two until their temperatures are equal |
| Entropy | * State of disorder |
| Matter does not contain heat  heat | * It contains internal energy * - It contains molecular kinetic energy and possibly potential energy, not heat. * Always moves from high energy to low * Once transferred, the energy ceases to be heat. * A substance does not contain heat—it contains internal energy. |
|  | * If one object gets colder; the heat must go somewhere |
| Internal energy | * Which has more internal energy (cup of boiling water/iceberg) * Remember- temp is measured from 0 K * The iceberg has more energy |
| [**Internal energy**](javascript:;)  potential energy | * Is the total of all energies inside a substance. * due to the forces between molecules. |
| Temperature  Heat  Entropy | * is measured in degrees; * is measured in joules. * when ice is melting, the added heat does not increase molecular kinetic energy but goes instead into other forms of energy. Just as dark is the absence of light, cold is the absence of thermal energy. * state of disorder- Heat never flows of itself from a lower-temperature substance into a higher-temperature substance * How much heat flows depends not only on the temperature difference between substances but on the amount of material as well |
| SI unit  Calorie; c | * 1 calorie = 4.184 Joules |
| * Measuring Heat | * The object does not contain work; it does work * heat is a form of energy- measured in joules or in US- calorie * If you add 1 calorie of heat to 1 gram of water, you’ll raise its temperature by 1°C. * an input of 4.184 joules raises the temperature of 1 gram of water by 1°C * 1 food Calorie = 1 000 calories |
| Specific Heat Capacity  of any substance is the quantity of heat required to change the temperature of a unit mass of the substance by 1 degree. | * Different substances have different capacities for storing internal energies. * A substance that gains/loses quickly; low specific heat * The slower the temperature change, the higher the specific heat * The energy may increase the jiggling motion which raises the temperature; or it may increase the amount of internal vibration or rotation within the molecules and go into potential energy, which does not raise the temperature. Generally, a combination of both occurs.   Specific heat capacity is a sort of thermal inertia since it signifies the resistance of a substance to a change in its temperature.   * a low heat capacity- the substance quickly warms and quickly cools |
| Water High Specific Heat Capacity | * Changes temp slowly * Moderates temp of islands & Europe (as water gets colder moving north…) |
| Thermal Expansion  Telephone wires  The expansion of  a bimetallic strip  Liquids  gasoline  Liquid water | When the temperature of a substance is increased, its molecules or atoms jiggle faster and move farther apart, on the average- result is an expansion of the substance   * With few exceptions, all forms of matter—solids, liquids, gases, and plasmas—generally expand when they are heated and contract when they are cooled. solids, these changes are not very noticeable- * become longer and sag more in heat * substances must be accommodated in structures and devices of all kinds.   A civil engineer uses reinforcing steel with the same expansion rate as concrete.   * gap in the roadway of a bridge is called an expansion joint; it allows the bridge to expand and contract * . * Different substances expand at different rates.   When the strip is heated, one side of the double strip becomes longer than the other, causing the strip to bend into a curve. because the metal that expands more also shrinks more.   * expand appreciably with increases in temperature. * overflows a car’s tank on a hot ; expansion of the glass of a thermometer * is denser than ice because water molecules in a liquid are closer together than water molecules frozen in ice, where they have an open crystalline structure. Water, like most other substances, expands when heated. it doesn’t expand in the temperature range between 0°C and 4°C. Something quite fascinating happens in this range... |
| Ice has a crystalline structure | with open-structured crystals. Water molecules in this open structure occupy a greater volume than they do in the liquid phase. This means that ice is less dense than water. The six-sided structure of a snowflake is a result of the six-sided ice crystals that make it up |
| ice  Water at the bottom of an ice-covered pond is 4°C, - most dense | * forms at the surface. * bodies of water not ice covered water must be cooled to 4°C before lower temperatures can be reached. * Because of water’s high specific heat and poor ability to conduct heat, the bottom of a deep body of water in a cold region remains at a constant 4°C year-round |

**Ch 16 Heat Transfer**

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| Conductors & Insulators  Insulator  Conductor- heat & electricity (energy) | Based on how the valence shell electrons act  Valence electrons held tight ( air, wood, asbestos) barefoot on coals  Valence e- loosely held; Metallic bond- best; silver best, copper, Al, Fe  Not good conductors- liquids & gases (20 outsides- you would be 20?)  Snow slows movement due to crystal w/spaces |
| Ex. same temp/different feel | Stone/wood floor; single vs. double paned windows  Pizza oven/air in it; a 5 pound blanket vs. five 1 pound blankets |
| **Conduction** | Particles must be in contact to transfer. Direct collision/more energy transferred; if hit as it is moving away from a collision- less energy |
| **Convection** | Heat transfer due to motion of fluid itself |
| **Radiation**  Radiant energy can move through vacuum of space  Electromagnetic waves | [http://t2.gstatic.com/images?q=tbn:ANd9GcQqKwDvXC4s8bGko7TvybL28hsHllKe33KeyPHBdNyS_IikoVtsNA:www.lcse.umn.edu/specs/labs/images/spectrum.gif](http://www.google.com/imgres?q=electromagnetic+spectrum&hl=en&safe=active&sa=X&rlz=1T4WZPC_enUS401US402&biw=1152&bih=600&tbm=isch&prmd=imvns&tbnid=UroavfiHPDiNuM:&imgrefurl=http://www.lcse.umn.edu/specs/labs/glossary_items/em_spectrum.html&docid=KU8v_UTdBn1FEM&imgurl=http://www.lcse.umn.edu/specs/labs/images/spectrum.gif&w=600&h=400&ei=ubq6ToTjCMfTgAfi-pXmCA&zoom=1)  Frequency = rate of vibration of waves; low have long; high produce short.  Low frequency vibrations produce longer waves. |
| Terrestrial radiation |  |
| Expansion  Winds pg 310 | Cools b/c particles which were close together are spread out & have fewer collisions.  Average speed decreases  Steam is condensed water vapor  Sea breeze/land breeze; landward during day; seaward at night |
| Absolute zero | Any substance above absolute zero emit radiant energy  High temp= high frequency radiant energy (on electromagnetic spectrum)  Ex. Sun- high temp= high frequency= visible spectrum  Earth- Lower temp = lower frequency than visible |
| Terrestrial radiation | Radiation (glow) produced by earth |
| Both the sun & earth glow  Due to nuclear reactions. | The sun due to nuclear fusion H + H 🡪 He  Earth- nuclear fission- breakdown of Uranium &some other heavy atoms  Atm. Transparent to high freq solar which passes through but is opaque to lower freq terrestrial- contributes to greenhouse effect |
| All objects emit radiant energy | In a mixture of frequencies & wavelengths  Infrared radiation called heat radiation |
| When hot enough objects glow | Low freq= red  Short= yellow to white (white light) |
| Everything is emitting and absorbing energy | Good emitters are also good emitters; Poor emitters=poor absorbers  Good radio receivers are also good emitters |
| Emission from black | Heats up faster in sunlight and cools faster at night  Ex. Emission depends on temp of surroundings; from hot to cold |
| Reflection of radiant energy | adsorption & reflection are opposite processes  Good absorber reflects little radiant (visible) energy; looks dark; eye pupil  Good reflectors = poor absorbers; snow; clean melts slower than dirty snow  Good reflectors= poor absorbers |
| Emission & absorption; | visible spectrum are affected by color  infrared spectrum more affected by surface texture; dull emits/absorbs better than polished regardless of color |
| Cooling by radiation | Moves from high energy to low energy  If object is good conductor- heat conducts from it to ground- stabilizes temp  Poor conductors= little heat conducted from ground; are NET RADIATORS- get colder than the air;  Covered plants do not freeze; prevents loss of heat to env. |
| Temp of space | 2.7 K w/weak radiation of the low temp |
| Newton’s Law of cooling  Rate of cooling ~∆T | Rate of cooling; how many degrees change in temp /unit of time  As an object cools, it heats the surroundings; the greater the temp difference, the faster the rate/exchange |
| Wind chill; | A wind chill of -20 C means heat is lost at same rate as if the temp were -20 C without wind. |
| Green House effect  Warming of lower atm | Earth absorbs solar radiation & emits terrestrial radiation. Absorption & emission at equal rates; last 500 000 yrs temps been between 19 to 27 C |
| Solar Power  passive  active | Over each m2 of area perpendicular to sun’s rays provides 1400 J/sec  Solar constant 1.4 kj/s/m2 or 1.4 kW/m2  Not yet cost effective when compared to traditional  Uses no electricity to use the energy  Produce electricity to run objects- |
| Controlling heat transfer  Vacuum bottle | Heat transfer by conduction through the vacuum is impossible. Some escapes by conduction through the glass & stopper, but it is slow |
| No loss by convection; no fluid to convect |
| Silver sides reflect heat back into bottle- reduces radiation loss of heat |
|  | Why does opening a window cause a room to cool- based on physics? |
| Ch 17 change in phase |  |
| Evaporation  Boiling  Read pg 330 | Liquid (lower energy) to gas ( must gain energy from environment) causes cooling  Looses molecule on surface to air causing drop of internal energy in the solution left; leads to cooling  Liquid to a gas absorbs surrounding energy  A COOLING PROCESS |
| Condensation/ freezing | Strike surface & energy is absorbed by fluid, inc  liquid temp - A WARMING PROCESS. At ground level- fog |
| condensation  freezing | Gas (high energy) to liquid (lower energy) 🡪 releases energy 🡪 heat produced  Liquid (high energy) to solid (lower energy)🡪 loses energy  Solid (low energy) absorbs energy to become liquid🡪 absorbs energy= cooler |
| Pressure affects temp | It is the temp that cooks the food, not the process  At lower pressures you will have lower boiling pts so the food will need to cook longer  Boiling & freezing can occur at same time dependent on pressure |
| What takes the most energy for 1 g of water?  Melting/freezing  Heating liquid water 1 C  Vaporizing 1 g of H20 |  |
| Ice  0 C  Liquid  100 C  steam | Below to 0; add energy  Stays at this temp until avg energy of all particles is 0; melt/freeze (when all ice is gone, the temp will increase)  From 0 to 100  Stays at this temp until avg energy of all particles is 100; vaporize/condense  100 & above |
| Laws of thermodynamics | 1st -(Law of Conservation of Energy)You don’t gain or lose energy through transfers- the amount is constant  2nd Entropy- nature tends to a state of disorder; energy never flows from cold to hot |
| Adiabatic  (no heat added)  Thermal inversion | Increase pressure 🡪 increase temp; dec pressure 🡪 decrease in temp  Chinook- warm breeze off Rocky Mtns  Layer of warm air prevents air below rising; pollution problem |
| **Regelation** | process of melting under pressure and the subsequent refreezing when pressure is removed  ice crystals collapse and allow the metal wire to move through the block: it refreezes as it moves through the ice. |
| Solar power | Wind is caused by uneven heating of earth |